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This task continued work toward development of a new trainer for the Javelin weapon system, and focused on incorporating a system for rendering 3D models of targets into the previous prototype software.

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Trainer Software Development

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October 15, 2001

Final Report

F/DOD/ARMY/AMCOM/Trainer Software Development
DAAH01-97-D-R005 D.O. 8

Period of Performance: 5/13/98 to 12/31/98

1. Introduction

This task continues work performed under a previous task (DAAH01-97-D-R005 D.O. 3) entitled "Basic Skills Trainer Software Development" in the development of a new trainer for the Javelin weapon system, called the Enhanced Producibility Basic Skills Trainer (EPBST). During the period of performance of this task (latter part of 1998), the project moved from technology study to requirements specification and initial development. The decision was made to use the Microsoft Windows operating system as a platform for the EPBST software, and to use 3D models for targets to provide a realistic rendering of the targets as they move about the terrain scenes. The final report on the previous task documented software for creating terrain models (Range Finder) and for creating target paths within a terrain model and displaying targets moving along those paths. The prototype software at that point in development demonstrated much of the critical technology needed to satisfy the requirements under consideration; however at that point we did not yet have a system for rendering 3D target models. Developing such a system was a significant portion of the work under this task, and is a focus of this report.

2. EPBST Targets

The EPBST targets are 3D models of military vehicles such as tanks and airborne targets such as helicopters. A number of sources are available for these 3D target models. We decided to use VRML (Virtual Reality Modeling Language) as the format for the target models, specifically a subset of the VRML97 specification, which can be found online at http://www.vrml.org/Specifications/VRML97. By subset we mean that our target files meet the specification (and thus can be viewed by readily available software such as internet browser plugins), but must conform to additional requirements in order to be recognized and understood by EPBST software. Generally targets in formats other than VRML can be converted to VRML using readily

available software utilities. Since VRML is an ASCII format, the file can be further edited, if necessary, to meet our requirements using a text editor. The EPBST software expects two versions of each target to be present: one for visible viewing mode and another for IR. Generally these two versions will have the same geometry, but different colors and textures.

The target model file format is indicated by the following features and example. Note that the example includes lines containing only "..." which are not literally part of the file but rather indicate where additional lines of a similar form have been omitted.

1. The file begins with the standard VRML97 header line. Following that is a series of Shape nodes, which may optionally be enclosed in Transform nodes, specifying a translation, rotation, and/or scaling. Each node is preceded by a comment line containing a description field for the shape. Comments in a VRML file are delimited by a sharp symbol (#) and end-of-line. The word "rotor" in a description field is used to specify animated helicopter rotors, with the animation based on the rotation field of the enclosing Transform node.

2. Each Shape node contains an Appearance node and an IndexedFaceSet node. The Appearance node contains a Material node and optionally an ImageTexture node; if a texture is present the texture file must be a standard JPEG file whose filename is given without any preceding url address or directory path information. The IndexedFaceSet must contain coord and coordIndex fields and, if a texture is present, texCoord and texCoordIndex fields. The texture coordinates must lie in the range 0.0 - 1.0.

Example File

```
#VRML V2.0 utf8

Transform {
   children [
      # hull
      Shape {
         appearance Appearance {
            material Material {
               diffuseColor 1.000 1.000 1.000
               specularColor 0.000 0.000 0.000
            }
            texture ImageTexture {
               url "bmp2a.jpg"
            }
         }
         geometry IndexedFaceSet {
            coord Coordinate {
               point [  # 160 vertices
                     -1.10051    0.34786   -1.95022,
                      1.10081    0.44943   -2.52760,
                      ...
               ]
            }
```

```
          coordIndex [ # 96 polygons
             88 86 87 63 -1,
             157 156 154 155 -1,
             ...
          ]
          texCoord TextureCoordinate {
             point [ # 208 texture points
                0.137249 0.548782,
                0.443396 0.544333,
                ...
             ]
          }
          texCoordIndex [
             115 112 113 114 -1,
             205 204 202 203 -1,
             ...
          ]
       }
    }

    # turret
    Shape {
       appearance Appearance {
          material Material {
             diffuseColor 1.000 1.000 1.000
             specularColor 0.000 0.000 0.000
          }
          texture ImageTexture {
             url "bmp2b.jpg"
          }
       }
       ...
    }
  ]
}
```

3. Target Paths

The EPBST software uses predefined target paths, each path being stored in a file containing a sequence of locations in ground coordinates for a target to follow. Most of the concepts discussed in section 3.1.6 (Target Path Concepts) of the final report for the previous task have been retained in the transition to 3D target models. Targets and their paths are designated as ground or aerial. At initialization, we subdivide each ground path at locations where the path crosses an edge of the ground triangulation. Thus following the initialization processing, each path consists of a series of segments along which the target is either stationary or moving in a straight line. A time is given in the path file for each segment, specifying how long the target will spend on that segment. Stationary segments are allowed; i.e. consecutive stored vertices at the same ground coordinates. With each path segment we associate a rotation from target to ground coordinates. For stationary segments, this rotation is specified in the path file; for other segments it is computed based on direction of travel. These rotations are handled as quaternions, which allow us to interpolate between them, and thus smooth the transition between path segments.

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                     ...
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            }
```